REFERENCES

- 1 Nigrovic V. Succinylcholine, cholinergic receptors and catecholamines: proposed mechanism of early adverse haemodynamic reactions. *Can Anaesth Soc J* 1984; 31: 382-94.
- 2 Paton WDM. The effects of muscle relaxants other than muscular relaxation. *Anesthesiology* 1959; 29: 453-63.
- 3 Goat VA, Feldman SA. The dual action of suxamethonium on the isolated rabbit heart. *Anaesthesia* 1972; 27: 149-53.
- 4 Nigrovic V, McCullough LS, Wajskol A, Levin JA, Martin JT. Succinylcholine-induced increases in plasma catecholamine levels in man. *Anesth Analg* 1983; 62: 627-32.
- 5 Löffelholz K. Release induced by nicotinic agonists. In: Patton DM, ed. *The release of catecholamines from adrenergic neurons*. Oxford; Pergamon Press 1979; 275-301.

REPLY

I thank Dr. Baraka for his kind letter commenting on the hypothesis concerning the mechanism of the early adverse haemodynamic reactions to succinylcholine (SCh) and for offering an alternative hypothesis.

In general, Dr. Baraka concurs with the essential points of the hypothesis. The reason he perceived the need for supplemental suppositions may be attributed to an incomplete consideration of the hypothesis. In his rendition of the original hypothesis, Dr. Baraka emphasizes one aspect of the hypothesis (*viz.*, the modulation of the release of norepinephrine via the interaction of SCh with the presynaptic cholinergic receptors on the sympathetic terminals) to the detriment of the other (*viz.*, the interaction of SCh with the postsynaptic cholinergic receptors). The neglected part is subsequently introduced as an alternative hypothesis.

First, the action of SCh on the sino-atrial node is, in fact, duly considered in the hypothesis. The notion that SCh can activate the (postsynaptic) muscarinic receptors at this site and cause bradycardia is indeed an old one. Our hypothesis goes beyond this fact. In its essence, it offers an integral picture of the pharmacologic actions of SCh at the level of the autonomic receptors. Based on these considerations, expected responses at the level of the whole organism are derived and the correlations with clinical reports outlined. The notion is proffered that these autonomic responses (both the pre-existing and the pharmacologically induced ones) in conjunction with hyperkalaemia determine the extent and the character of the SCh-induced haemodynamic crises.

In the context of the hypothesis "... the mutually opposing effects resulting from the activation of these cholinergic receptors by succinylcholine ..." refers to all

cholinergic receptors (both pre- and postsynaptic, muscarinic and nicotinic) and not just to presynaptic cholinergic receptors on the postganglionic sympathetic terminals. Certainly, were the whole hypothesis restricted to these only - as interpreted by Dr. Baraka - there would indeed be a need for additional postulates. The hypothesis, however, as originally presented does incorporate these ideas.

The second point put forward by Dr. Baraka is the suggestion that SCh activates the cholinergic receptors in the autonomic (sympathetic and parasympathetic) ganglionic cells. Although this notion has been entertained frequently in the past, the following critical point has not been considered: interaction of SCh with the cholinergic receptors on the ganglionic cells would produce not only an initial activation but also a subsequent inactivation of these receptors. During the inactivation phase all autonomic reflexes would be abolished for as long as SCh is present (receptors maintained chemosensitive). However, neither the infusion of SCh nor the decreased degradation rate of SCh in patients with abnormal pseudocholinesterase have been reported to produce the clinical picture of an autonomic (sympathetic and parasympathetic) areflexia. In addition, the data documenting the release of norepinephrine - as cited by Dr. Baraka - are easily and adequately explained by postulating only an activation of the presynaptic nicotinic receptors on the postganglionic sympathetic terminals. Thus, I believe that the notion of a clinically important interaction of SCh with cholinergic receptors in the autonomic ganglia, although perhaps possible, is not likely.

The third point of Dr. Baraka's alternative hypothesis is the suggestion that SCh might lead to a depletion of norepinephrine (NE) stores in the sympathetic terminals. This interesting suggestion is not supported by the available pharmacologic and clinical information. First, even under the most extreme experimental conditions, depletion of NE stores requires relatively prolonged treatment with suitable agents. Repletion is also a prolonged process. Second, the sudden massive release of NE to the extent of depletion of the NE stores would be expected to produce a haemodynamic crisis. This is clearly not the case after the customary intravenous bolus administration of SCh. Moreover, the depletion of NE stores on the sympathetic terminals would not account for other clinical observations (*e.g.*, a critical time interval between the first and the second injection of SCh, the more frequent occurrence of bradycardia in infants, etc.). Our hypothesis also offered pharmacologic interpretation for clinical observations after the slow infusion of SCh or after the intramuscular administration. Thus, I do believe that SCh may lead to a fractional release of NE from the stores at the sympathetic terminals. I doubt that a depletion of the stores is likely.

Lastly, Dr. Baraka comments on SCh-induced hyperkalaemia and malignant hyperpyrexia. The relationship between increased concentrations of potassium in the extracellular fluid, catecholamines, and the anesthetic agents is complex. According to our hypothesis, hyperkalaemia is only one event in the sequence of events leading

to haemodynamic crises. Hyperkalaemia has been amply documented in the past because it was searched for. The other events (e.g., massive response of the sympathetic system or an absence of the sympathetic response) may be demonstrated if deliberate attempts are made in the future to document it. The development of malignant hyperpyrexia is a relatively late event after the administration of SCH and therefore goes beyond the confines of the hypothesis.

Some of the suggestions proposed by Dr. Baraka fall well within the frames of the hypothesis and are discussed there. The other proposals appear unlikely.

Again, I thank Dr. Baraka for his comments.

Vladimir Nigrovic MD
Departments of Anesthesiology and Pharmacology
Medical College of Ohio
Toledo, Ohio 43699 U.S.A.

Single segment combined subarachnoid and epidural block for Caesarean section

To the Editor:

Epidural and subarachnoid blocks are well-established methods of regional anaesthesia for Caesarean section. However, these techniques have certain drawbacks. Both techniques are associated with a relatively high risk of maternal hypotension which may be precipitous following subarachnoid block and can lead to neonatal depression.¹⁻⁴ Difficulty in controlling segmental spread of analgesia may be another disadvantage of subarachnoid block. Also, due to requirement of large doses of local anaesthetics for epidural block there is a risk of toxic complications.^{5,6} Furthermore, in spite of large doses epidural block may fail to provide adequate analgesia in up to 25 per cent of patients due to difficulty in blocking sacral roots.^{3,7-9} A technique is described which combines the reliability of subarachnoid block and the flexibility of epidural block while minimizing or eliminating their drawbacks.

Twenty-four healthy patients scheduled for elective Caesarean section were included in the study after obtaining their informed consent. Before induction of combined subarachnoid and epidural (CSE) block about 1500 ml of fluids warmed to 37°C by a blood warmer were administered IV over

FIGURE Twenty-seven gauge spinal anesthesia needle inserted through a 16 gauge Tuohy needle previously placed in epidural space.

a period of 15–20 min. With the patient in the sitting position a 16 G Tuohy needle was inserted at the L2-3 interspace and the epidural space identified. A long 26 or 27 G spinal needle was introduced through the caudad directed Tuohy needle and the dura penetrated. After correct placement of the spinal needle was confirmed 1.5–2.0 ml of 0.5 per cent hyperbaric bupivacaine (depending on the height of the patient) were injected into the spinal needle which was then withdrawn (Figure). The Tuohy needle was rotated 180° cephalad and a catheter introduced into the epidural space. After securing the catheter firmly by tape the patient was placed in the supine position with left uterine displacement and the head of the operating table elevated 10–15°.

After the spinal block was "fixed" (about 15 min) and extent of analgesia noted the block was extended to the T4 dermatome by injecting fractionated doses of 5 ml 0.5 per cent bupivacaine in the epidural catheter. The epidural catheter was also used to provide postoperative analgesia on demand by administration of 4 mg morphine. Early ambulation was encouraged following regression of CSE block. Following surgery 10 ml of saline was injected every four hours in the epidural catheter. The epidural catheter was removed after 48 hours.

The mean dose of 0.5 per cent hyperbaric bupivacaine given for subarachnoid block was 1.7 ± 0.2 ml S.E.M. (range 1.5–2.0 ml) and the